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## SCIENCE TEACHING IN OUR PUBLIC SCHOOLS.

Only a single generation carries us back in the history of our public schools to the reign of the "three R's." From that time to the present the curricula of our schools, both city and country, have at indefinite but frequent intervals been revised and extended, so that now our district or grammar-school grades touch upon most of the academic studies, and our high schools cover, at least in so far as subjects go, our college courses.

In this paper I propose to consider briefly the effect of this distension of our courses upon the pupils of the schools as to results in scholarship and culture, in aim and ambition, and to consider more fully the advisability of dropping from our public school courses especially those sciences which can be taught successfully only by the laboratory methods.

I have no intention of disparaging the present as compared with the past, for I fully believe that the progress of the race is upward and onward,—not downward and backward. But further progress comes, not by letting well enough alone, but by a careful study of *present* results and by the formation of wise plans for securing greater and more desirable ones. No new scheme or plan in education or anything else is found to be wholly wise or desirable, but discussion and agitation causes those ideas in which there is real life to crystallize out. From these ideas the race constructs itself a scheme in the execution of which it is carried forward and upward to a higher plane.

The history of an individual, a community or a nation, no matter how grand may have been the progress as a whole, never shows an uninterrupted series of successes. The failures and mistakes have been the starting points for grander and more enduring achievements. If we are making educational mistakes, let us, by conference and discussion discover just wherein those mistakes lie, and then, placing these behind us, once more move out along new lines.

We are all conversant with the great diversity of our public school courses of study. If the present generation of pupils do not rise much higher than their ancestors in general culture and power, it will not be because their angle of vision is too small but because they fail to secure depth of vision.

President J. M. Coulter, of the Indiana University, in a recent article in the *Educational Review* says it is the spirit and mission of a university to make men think for themselves. Are we not justified in saying that *that* should be the object of education, whether in the public school, the college, or the university? It should be the mission of these three successively more and more to accomplish man's emancipation from "second-hand thought."

Now is not a limited number of subjects more likely to produce thinking men than a mere smattering of the whole complement of the arts and sciences? I shall not here make a comparison between the results of past and present schools as shown by the number of great minds produced respectively in successive generations, though I do believe that a larger percentage of the pupils who entered the higher institutions of learning in the past attained to eminence than is the case at present. Many reasons might be assigned for this, but not the superiority of the courses or the instruction. The men of great scholarship and culture in the past became so because of great inherent power and indomitable perseverance. But while the percentage was greater, the actual number attaining to high scholarship was very much smaller. This being the case, what I want to arrive at is this: Are present results at all commensurate with our expenditure of time, money, and energy? The educational effort put forth ought to develop a generation in which the man who thinks for himself should be the rule and not the exception. Has it done it? Has the introduction of a little of all the "ics" and "isms" and "ologies" into the public schools made the average boy and girl cherish more dearly their educational advantages? I doubt it. How many pupils have remained in school an additional year or even a month because they were going to receive nice little talks on flowers and birds, on elements and compounds, on levers and cranks, on matter and mind? Any? Possibly. Many? Probably not.

The introduction of so much into the course I think has not only *not* secured higher scholarship and culture than would be secured by fewer subjects and better instruction, but it has actually fostered in them a dependence that has lowered both aim and ambition. My reasons for making these statements will appear further on. For the present I wish to assume that the laboratory sciences are the ones to be eliminated.

In support of these assumptions I shall give some reasons which I shall group under two main heads: *First*, It is necessary to shorten the time required to secure a collegiate education. *Second*, It is impossible, under present conditions, successfully to teach the sciences, especially those requiring laboratory equipments, in our public schools. In support of the first let us note the time required to secure a professional training. The child enters school at six, eight years are allotted to the primary and grammar grades, four more to the preparatory school or the high school. At the age of eighteen, if health and opportunity have favored the pupil, he is ready to begin his college career. Again, supposing circumstances, financial and otherwise to be propitious, the average student finishes his college course and receives his degree at the age of twenty-two. If, as is often if not usually the case, the necessity arises for making part of this time productive in a financial way, this period is increased from one to five years. These self-supporting students must not be ignored in our educational scheme, for they are not only often the brightest students in our classes, but they are in later years the ones who fill a large part of the positions of trust and honor everywhere.

At ages ranging from twenty-three to twenty-seven these self-made students find themselves in possession of a diploma testifying to their general knowledge and culture, but without any special preparation for their life work.

But let us specially consider the more fortunate student who is permitted to pursue his studies uninterruptedly, and who at twenty-two looks about him and chooses the occupation or profession he would pursue. His choice having been made he seeks to enter it, but finds it has not the keys to the portals through which he would pass. He may be permitted to stand on the steps of the citadel and gaze down the long corridors leading to the upper chambers that he longs to enter and possess. From two to four years more must be spent in professional study before these coveted places throw open their doors. Law, medicine, and theology, pedagogy, civil, electrical and mechanical engineering, pharmacy, architecture—everything to which we aspire—no longer invite the person with general culture to enter and learn by experience at the expense of the patient or patron. He must present himself equipped with that special training which it is the function of the true university or professional school to im-

part. It was not always so, but with the great increase in general knowledge among the people, the rapid development of science, pure and applied, the sharp competition every day becoming sharper, he who would succeed must pay the uttermost farthing. While it was possible thirty or forty years since for the man with good common sense and some general knowledge to attain to a degree of success in almost any field of labor, he now finds the man who has his general knowledge crowned with special training in a definite line, outstripping him in the race of life.

As our courses of study are at present arranged it requires that our boys remain in school through youth and young-manhood ; the prime of life is reached before a young man is permitted to enter the fields where he is to do battle with life's duties. It is true, of course, that he who enters late, if well equipped, will be awarded the victor's wreath over his brothers who have toiled longer in the field. It is better to remain out of life's active duties, under the present conditions, even until thirty if necessary, rather than enter ill prepared.

But of the vast armies of youth in our public schools, how many have either the means or patience, or even the desire to enter the halls of higher instruction? I do not mean that our colleges are being deserted. On the contrary the attendance is increasing ; but even then how few get beyond the grammar grades, and fewer yet beyond the high school and academy.

There is a crying need that something should be done to enable our young men to reach their college courses earlier in life. If the time can be shortened from one to four years, it will certainly give us a generation with a much larger number of men well equipped for the duties which our advancing civilization requires.

How to gain, or rather to save our young men and women these years during their vigorous and productive period of life, and yet not diminish their efficiency, has been the all important question for discussion during the few years just past. Commencing at one end, it has been suggested that the professional course be shortened. Again, that the college course be condensed into three years. Further, that the preparatory or academic course be lightened. Each of these propositions, after due discussion, is pronounced impracticable.

Indeed the logic of events has emphasized the fact that the demands of the times are for college-bred men with greater, not less, professional training. The most successful schools of law and medicine are gradually lengthening their courses, and what is more significant, one or two are already requiring a college diploma as the condition of admission. As people are now demanding the highest professional skill from those who serve them in any capacity, all schools must soon follow in the steps of those that have set the higher standard. Where, then, shall time be saved, if our college courses cannot be abridged and our professional courses are being lengthened? From one of the most conservative of institutions comes a most radical suggestion. President Eliot, of Harvard, finds the remedy in eliminating from the primary and grammar grades much that is either irrelevant, or that has received an undue amount of time. His suggestion is that pupils can be prepared for the high school and the academy, and consequently for the college, at a much earlier age than now. This suggestion was received with a burst of surprise on all sides, but coming from so eminent an authority, it at least secured the attention of educators everywhere. Strange to say, the more the proposition has been discussed, the more have his opponents acknowledged the reasonableness of his suggestion.

Now what are the facts upon which he bases his belief that the time may be shortened? I will give you the leading one. He selects a typical academy or preparatory school, (Phillips Academy, Exeter), finds its courses of four years full and valuable; its standard of admission about the same as that of similar institutions east and west, viz : some knowledge of common school arithmetic, writing, spelling, and of the elements of English grammar. These are requirements, President Eliot thinks, which might reasonably be expected of a boy leaving the primary school at the age of eight years. But at what age, in fact, do our pupils reach high schools and preparatory schools? President Eliot finds the average age to be sixteen and one-half years. Even admitting that President Eliot is radical, and that he expects too much of an eight year old boy, I think most of us must admit that the foregoing requirements are not too much to expect of a ten-year-old boy. How then shall we justify or explain the use of the six and one-half years more that we dawdle over before we admit him to preparatory work? It seems in the face of these facts

that we stand condemned in the light of our own judgments for an awful waste of the precious formative years of youth. But that is not all, nor the worse fate that overtakes our youth in these years of comparative indifference if not of idleness. We all know too well that the pupils who leave our grammar grades with high ambitions and aims as to future scholarship and culture are the exception and not the rule. If this charge is true, and I believe it is, it is high time we were aware of it, and were looking for the cause.

I shall not attempt to find all the causes, for I have neither the time nor the ability to go deep enough below the surface to lay bare all the causes affecting our educational results. A few, however, I think are not far to seek. First and foremost I think is our attempt to cover so many subjects in such diverse fields. We attempt too much as to the number of subjects, but too little as to subject-matter. We lay our foundations so broad that we fail to secure depth. We are not content even in the primary grades simply to put into the hands of the pupils the key to further knowledge, viz: reading, spelling, and numbers, but we at once proceed to give them a little dilute geography, and grammar, and science, under various disguises, but always so dilute that there is no meat in it for the growing mind. This process is continued through the various terms of the eight long years, with a little more science here; a little more geography and history there. Hash sandwiches are the daily diet; the hash composed of a little drawing, and book-keeping, and language, and nature lessons, and "what not," spread infinitely thin over nearly as thin slices of the more substantial fare which varies but slightly from year to year.

The drift of nearly all pedagogical literature, as we all know, has been for years to emphasize the necessity of enriching the public school course. As a result we have enriched it by constantly diminishing the amount of the staples of life, and supplying the deficiency by a microscopic amount of most varied but badly prepared desserts. The result of this enrichment of the course has led, I believe, to another mistake, viz: the repetition in successive years of the same subject, varied somewhat, it is true, but to the pupil new but once. A series of books in physiology and hygiene, oral lessons in botany, oral lessons on animals, and these presumably each used as the basis of a language

lesson, and so on through the years, but at the end the pupils know but little about plants and animals, and possibly less about language. Only recently I heard just such a boy say, "I seen him when he done it, for I hadn't went home yet."

We have had it dinned into our ears for years that the secret of developing a retentive memory, a discriminating judgment and a vigorous reasoning faculty, is to be found in the magic words, *repetition, repetition, repetition; review, review, review*. Do you believe it? Not if you think of it seriously. He who would develop the above inestimable qualities in his pupils will do better by going over a subject thoroughly, stating facts and principles in such a way that judgments may be formed from them, and conclusions deduced.

State superintendent McKibben, of Michigan, in a paper on the Revision of the Michigan Course of Study, gives many valuable suggestions as to the relation of the high school to the university, but he perpetuates the folly that has too long prevailed, "that the child can be taught a little of everything, and yet maintain an interest in anything." I quote a paragraph which you will all recognize as a fair sample of what has been the burden of all educators and journals for some years, but of which I trust we shall see less and less in years to come. He says: "This work in science, this study of Nature should begin when the pupil enters school, and should continue without interruption till he leaves it. At first it need not necessarily be botany, or geology, or geography, or astronomy, or physics, or physiology, or zoology, or chemistry that he studies, but something of each." . . . "After the first two years this observation work will differentiate into geography and the natural sciences; the former during the next three years making a study of the earth, and framing a skeleton on which to build, (note, three years framing a skeleton on which to build in geography), the latter going over much the same ground as the first two years, but more thoroughly, and to classify the facts of nature under the different sciences. In the grammar grades the ground will be covered again, but the subject will be SCIENCE."

How many teachers, even if they could have the same pupils through the whole eight years, could maintain in all these subjects an unflagging interest, so that when they turned their charges over to the high school these should enter it hungering



and thirsting for more *science*? And this while the teachers carried forward the rest of the work in the course? How much more ridiculous it is to expect a succession of teachers to possess the mental equipment necessary for the Herculean task!

There is nothing so disheartening to us, either as teachers or as students, as to feel that we are accomplishing nothing. If students feel that they are getting but little food for their minds they become indifferent—absolutely so—even to that little. This is equally true of the pupils in the lower grades. They are epitomes of larger humanity. They want to feel that they are accomplishing something, that something has been done, that need not be done again. That one subject mastered may be placed under their feet as a stepping stone to something new, if not to something higher. Then there would be a living interest manifested in the successive subjects as they come. We grown people cannot maintain a lively interest in a dozen subjects at once. As our interest in one increases, our interest in others decreases. Did you ever know a lady to be infatuated with literature, china-painting, needle-work, foreign missions, etc., all at once? These may each successively be her “fad,” but never all at once. No more can any student’s or child’s mind be directed profitably to a large range of subjects at once. This is one of the facts that is helping to beat into the heads of colleges and universities the desirability of elective courses of study. Elective courses enable the student to concentrate his energies, whereas formerly, from the kindergarten to the college, the pupil’s energy was directed toward a bi-concave course of study, and the faint pencils of light, as they went out into time, diverged more and more widely.

Of course we all agree that the courses from the kindergarten to the high school must be general courses; that the ideas inculcated must be general ideas. But they need not therefore be distributed over the universe. I do not advocate a narrow, one-sided education; nor is that education narrow for a child which puts into his hands the key which will enable him to unlock any one of the rich store-houses that waits to be rifled of its boundless wealth. I have but little patience with that narrow spirit which has shown itself in a few places which would make industrial training clubs out of our public schools. We hear of mending and cooking and typewriting and wood-working being introduced

into our grammar grades. This so evidently misses the purpose of the public school that I need not consider it, but there are others who plead so earnestly for broad courses of study that we are compelled to notice the broadness we have already secured. We lay the foundation so broad that the superstructure never rises to symmetrical proportions. Possibly we not only lay the foundations broad, but so deep that our line of vision never rises above the earth. We want broad men and women but I ask you in all sincerity, who is the broader, the man with a full knowledge of a few things, or the one with a little knowledge of many things? This broadness I am condemning has led many a pupil, as well as many an older person, to think that he knows what he does not know. Now, is there any narrowness so narrow as that of one who doesn't know that he doesn't know?

One more evil result of this crowding of our courses I must notice. The absolute essential in mental development is *individual, personal* study and mental labor. We have spent much time of late in making the schools attractive. How has much of this been done? By introducing new subjects and having the teachers prepare the work. Pupils have come to expect the teachers to furnish in a condensed and palatable form all that need be known of any subject.

Hard labor, and the consequent mental development, are far too rare, not only in our public schools, but as a consequence in our higher institutions. A habit of dependence once formed, takes *time* and great energy on the part of subsequent teachers to counteract.

Having spoken thus fully of the first part of my subject, I will in a very few words consider the second: "Are the laboratory sciences the ones to be omitted from the course?"

Physics and chemistry have for years been admittedly taught successfully in connection with properly equipped laboratories. Botany and zoology more recently introduced into the courses are rapidly being placed on the same footing.

I think it may be considered axiomatic that we should not undertake what we cannot do well, so long as there are other things just as valuable that we can do better. Again, I think it is clear from what has already been said, that the majority of our public school teachers are not prepared to give suitable instruction in all the sciences. The day has passed when anyone can take all

knowledge for his province. Assumed enthusiasm will not pass for the genuine, and only the real article inspires the pupil. The world of knowledge is not only beyond individual capacity, but single subjects, such as botany or physics, go out in such varied and divergent lines, that it requires a specialist to see the ultimate known facts of even a single line.

What I have said thus far I have directed particularly toward the public schools below the high school. It requires more courage to apply the whole of it to the high schools as well. It is nevertheless true that our high schools are attempting far more than they can do well. Few, very few, are equipped with laboratories or properly trained teachers for the sciences in question. As proof of this I shall offer but one thing in evidence, viz: results. It stands to reason that if our science teaching in our public schools and academies were a success, the higher institutions would recognize our efforts in that line as they do in other lines. What are the facts? Out of one hundred and twelve colleges, scientific schools and universities having fifty or more students in their collegiate classes, sixty-eight require no knowledge of the sciences for admission to the Freshman class. Many more requiring some sciences, require no biology. Others yet require only elementary physiology and physical geography. Those requiring no sciences are not second-rate institutions. They are most of the state universities, Yale College, Williams College, Columbia College, Cornell University, and others of recognized standing. Those requiring elementary science are almost invariably those which have preparatory departments of their own where students are prepared for their college course. Harvard formerly required elementary botany for admission, but now she starts her young men, who are from sixteen to twenty-five years of age, in this subject as if they had neither seen or heard of a flower.

*Comment is unnecessary.* Facts are facts. We must either change our courses and methods, or else drop our science from our high school curricula.

I have time but for one suggestion. If we must have science in the high school course, let us be rational. Let us undertake but one or two subjects, and teach those thoroughly. There is more culture and mental power to be derived from one subject well taught, than from a smattering of all the sciences in the

whole realm of nature. I care not what subject you take. Botany, zoology, geology, chemistry, or physics. The subject having been selected, open up to the student such attractive but limitless fields that his arrogance, born of ignorance, shall flee away, and he shall humbly acknowledge that one field is more than he can master.

I know that in much that I have said I am going counter to all precedent, and that as a science teacher I might be expected to urge its introduction at any and every point. Now it is not that I love science less but truth more. Truth systematized is science, and science will prevail; but all science is not the province of finite beings.

Now I have not said a word against trying to cultivate in children a love for nature. If you *can*, do so by all means, but don't delude them with the suggestion that you are teaching them botany, or zoology, or chemistry, or geology. Teach them to love nature by bringing them in contact with her. The Germans take their classes for strolls in nature's haunts, and the pupils learn to love the birds and flowers, not by dissecting them, nor by arranging them in systematic groups, but by contact and association. The boy who plucks the flower from its mossy nook and feasts his eyes on its beautiful tints and drinks in its sweet perfume will love it, while the one who is told that a flower opens centripetally, is gamopetalous, with a ligulate corolla and syngynous stamens, will hate it on general principles if not for its names.

We all love nature, but not dreary platitudes concerning her. Exalt nature. Inspire love for her by reading or causing to be read beautiful stories of her various moods. But let these stories teach reading, and only incidentally a love for nature. They do not teach science. Let us in the public schools teach the essentials, and if we can, while doing so, keep ourselves and our pupils in touch with nature and nature's children.

*Aven Nelson.*

*University of Wyoming.*